

BIBLIOGRAPHICAL NOTICES.

FOSSIL CRINOIDS.

Paléontologie Française ou description des fossiles de la France.—Terrain jurassique, tome xi. première partie: *Crinoïdes*, par M. P. DE LORIOI. Paris: 1882-1884. Pp. 627, pls. 1-121.

Revision of the Palæocrinoidea.—Part III. *Discussion of the Classification and Relations of the Brachiata Crinoids, and Conclusion of the Generic Descriptions.* By CHARLES WACHSMUTH and FRANK SPRINGER. First Section. Extracted from the 'Proceedings of the Academy of Natural Sciences,' July 28, 1885. Philadelphia, 1885. Pp. 138, pls. iv.-ix.

WHEN reviewing Mons. de Loriol's monograph upon the fossil Crinoids of Switzerland in 'Nature' for August 4, 1881, we mentioned that he was engaged upon a similar work which would deal with the Neocrinoids found fossil in France. The results of his study of some of those which occur in the Jurassic rocks have now been published as the first part of the eleventh volume of the 'Paléontologie Française.' We think that the indefatigable author has every reason to be satisfied with his work, which cannot fail to be of the utmost use to all students of the Neocrinoidea, and indeed to every palæontologist who wishes to have the means of naming the numerous fragments of Apiocrinidæ which are so common in Jurassic strata.

The work before us, which consists of 627 pages of text with an atlas of 121 plates, is, however, much more than a mere enumeration of species, with descriptions of those previously unknown to science. The first thirty pages are devoted to a good general introduction, which touches upon the peculiarities of the Palæozoic Crinoids as well as of those of later date, with which the author is more immediately concerned; and it is illustrated by seven plates, which contain figures of the Pentacrinoid larva and of the more remarkable among the recent Crinoids which were known to the author at the time when he commenced his work. The student is thus brought face to face with the only method which can lead him to a right understanding of his collections; and it would be well if Mons. de Loriol's example were more frequently followed by those so-called palæontologists who think that life is too short for the study of the living representatives of their fossils. Every specialist could name one or more of these empirical writers, who are often most valuable as careful and zealous collectors, but come to utter grief when they attempt to deal with questions of structure. Of them may it truly be said "the evil that men do lives after them." For the old error, though corrected again and again, is continually being reproduced in text-books and elsewhere. The snake is never really killed, but only scotched, and the advance of real scientific knowledge is hindered in consequence.

Mons. de Loriol's introduction is followed by a chapter on classification, in which Zittel's arrangement of the true or brachiata Crinoids, the Cystids, and the Blastoids as orders of the class Crinoidea is adopted. But Palæocrinoidea and Neocrinoidea are wisely

used as subordinal designations instead of the misleading terms *Tessellata* and *Articulata*; and in accordance with this proceeding the *Marsupitidae* and *Uintaerinidae* are restored to their proper places among the *Neocrinoids*; while a new family, *Bourguetierinidae*, is very rightly established for *Bourguetierinus*, *Rhizocrinus*, and *Bathycrinus*, genera which differ considerably from the typical *Apiocrinidae*.

The remaining and by far the largest portion of the volume contains descriptions of the Jurassic *Eugeniocrinidae* and *Holopidae*, and of the three principal genera of *Apiocrinidae*, viz. *Guetlardicrinus*, *Apiocrinus*, and *Millericrinus*. Eleven species of *Eugeniocrinus* are described, including four new ones, *E. mayalis* being from the Lias and the remainder from the Oxfordien. *Phyllocrinus* is represented by seven species, three being new, and *Tetracrinus* by one; while a new genus, *Eudesicrinus*, is established for a remarkable type which has been referred both to *Plicatocrinus* and to *Eugeniocrinus*, and seems likely to find its true position among the *Holopidae*. Much new and valuable information is given about the singular type *Cotylecrinus*, which has also been found in the Dorsetshire Lias; and the curiously abnormal *Gymnocrinus* is described from better material than was available when the author worked out the fossil Crinoids of Switzerland. Besides *Guetlardicrinus* fifteen species of *Apiocrinus*, four of which are now described for the first time, occur in the French Jurassic strata, while the genus *Millericrinus* is represented by no less than sixty-four species, of which twenty-six are new to science. About one fifth of them are only known by their stems; but these are as a rule very well defined, and seem to afford good specific characters.

The most interesting morphological point which has been brought out by Mons. de Loriol's work is the presence of small underbasals in two species of *Millericrinus*. They do not appear at all upon the exterior of the calyx, as they rest upon the central part of the enlarged uppermost stem-joint and are concealed by the basals outside them. But they seem to be well differentiated, though relatively small; and it is quite probable that they will ultimately be found to occur in other species of the genus, though, as Mons. de Loriol says, they are certainly absent in many which he has been able to examine in detail, as his excellent figures show.

All working palaeontologists must be grateful to him for this most useful book and will welcome the appearance of the next volume, which will deal with the *Pentacrinidae* and *Comatulidae*, families which are both well represented in the French Jurassic strata, as indeed also in those of our own country.

The name of Mr. Charles Wachsmuth, of Burlington, Iowa, is so well and so favourably known to every student of the *Pelmatozoa* that the appearance of a new section of the 'Revision of the Palæocrinoidea' by himself and Mr. F. Springer is an event of considerable interest. Parts I. and II. were published in the years 1879 and 1881 respectively. The first and most important section of Part III., which appeared at the close of last year, contains a discussion of the classification and relations of the brachiate Crinoids, together

with the final revision of the generic descriptions in one of the three primary groups into which the Palæocrinoids are divided by the American authors. This portion of the work appears to us to be much the most satisfactory one. In the extent and accuracy of his personal acquaintance with the wonderfully complex generic types which are presented by the Palæocrinoidea Mr. Wachsmuth has no equal, we had almost said no second; and the immense mass of detailed information which he possesses concerning the intricate composition of calyx and vault in the Actinocrinidæ, Platycrinidæ, and Rhodocrinidæ is clearly and explicitly set forth in Parts I. and II. and in this first section of Part III. of the 'Revision.' The order Palæocrinoidea is divided by himself and Mr. Springer into three suborders, the first of which includes the three families just mentioned and all other Palæocrinoidea "in which the plates of the test are solidly united by suture, and in which the lower arm-plates are incorporated by means of interrarial plates so as to form a part of the calyx." For this group the name *Camarata* is proposed, while the *Articulata* (the *Ichthyocrinidæ* of Part I.) include "those families in which the plates of the test are united by loose ligaments or muscles, and in which they are somewhat movable." Lastly the group *Inadunata* (corresponding on the whole to the *Cyathocrinidæ* of Part I.) "is proposed for all Palæocrinoidea in which the arms are free above the first radials and which have five single interradians, located ventrally." The authors state that "these groups are not only well defined in nature, as shown by the fact that they are so readily recognized, but they are also most convenient for all descriptive and comparative work." In this remark we entirely concur, and we fully believe that the classification which the authors propose will stand the test of future research. It has grown up gradually during the many years of Mr. Wachsmuth's experience as a collector, and we doubt if any palæontologist will be able to improve upon it.

The view which the authors take of the Crinoids with regard to the other Echinoderms appears to us, however, to be a less satisfactory one. They follow the writer in adopting Leuckart's separation of the stalked Echinoderms under the name of *Pelmatozoa*, but only rank this group as a class equivalent to Urchins and Starfishes. The spirit of Leuckart's classification is thus entirely ignored, though it is partially followed in the letter, and we are taken back in principle to the grouping of the older systematists, in which Crinoids, Cystids, and Blastoids were all thrown together under the term *Crinoidea*, regardless of the fact that Miller's very explicit definition of this term implies the presence of articulated arms upon the radials, and that these appendages are absent in both Blastoids and Cystids.

Leuckart's separation of the *Pelmatozoa* from Urchins and Stellerids on the one hand, and from Holothurians on the other, has been abundantly justified by the physiological and morphological researches of the last twenty years; and the difference of a Crinoid from an Urchin or Starfish is far greater than their difference from one another, as was long ago pointed out by Professor Huxley.

Messrs. Wachsmuth and Springer, however, follow Zittel and de Loriol, and regard Pelmatozoa, Urchins, and Stellerids as equivalent classes of Echinoderms, which (as just remarked) is little more than a nominal change on the classification of forty years ago.

Following the principles of Burmeister's classification they divide the Pelmatozoa into two subclasses, Anthodiata and Brachiata or true Crinoidea. The first contains the two orders Cystids and Blastoids, while the second falls naturally into Palæocrinoids and Neocrinoids. There is more to be said for this classification than for that which we have just criticized. But we cannot help thinking that the Cystids and Blastoids are more divergent in character than the Palæocrinoids and Neocrinoids are, and that, as suggested by Professor Huxley, they deserve to be ranked as classes of Echinoderms equivalent to the Crinoids. This course was taken by the writer in the 'Challenger' Report, and has since been adopted by Ludwig, the leading German authority on Echinoderms, who also follows Leuckart, Ray Lankester, and others in giving the Pelmatozoa the rank of a branch and not merely that of a class of Echinoderms.

On p. 75 Messrs. Wachsmuth and Springer profess their inability to point out a single character of either Crinoids, Cystids, or Blastoids "that is not found exceptionally in one of the other groups." They admit, however, that "probably neither Blastoids or Cystids had appendages united by paired muscular bundles" (p. 78); and this is one of the essential characters of the true or brachiate Crinoids. Furthermore, there are at least two strong points of difference which distinguish the Blastoids from the Cystids. The hydrospires of the latter group are very irregularly disposed, while those of the Blastoids are grouped with the utmost regularity in five (or in one genus only four) pairs, which are limited to the radial and deltoid plates and occupy the interradian portions of the calyx, with their slits parallel to the ambulacra; and the small azygos basal of the Blastoid is always situated in the left anterior interradius. In all Palæocrinoids which resemble the Blastoids in having an unequally tripartite base, with one possible exception, the small plate is in the right anterior interradius; and we are not aware that any such symmetry is observable in the few Cystidean genera which have only three basal plates, except perhaps in *Cryptocrinus cerasus*. There are other characters, such as the ambulacral structures of Blastoids, which also differentiate them very clearly from the Crinoids and Cystids. We have yet to become acquainted with any member of the two latter groups which has a subambulacral "lancet-plate" like that of the Blastoids. The five lancet-plates of a Pentremite are pierced by longitudinal canals which unite into a circumoral ring, and, as we believe, contained the ambulacral or water-vessels. So far as our present knowledge goes, this subambulacral structure does not occur in any other Pelmatozoa but the Blastoida; and despite the number of apparently intermediate forms, we are strongly inclined to think that the three groups (Crinoids, Cystids, and Blastoids) are in reality much more distinct than has hitherto been supposed.

Messrs. Wachsmuth and Springer have changed their views upon several important points of Crinoid morphology since the publication of Part II. of their 'Revision.' Some of these changes have met, and probably always will meet, with the very general assent of their fellow-workers, such, for example, as the withdrawal of the designation "oral plates" from the calyx-interradials of *Cyathocrinus* and of the Blastoids. But in one case, perhaps the most important of all, we think that the change is decidedly for the worse.

Mr. Wachsmuth pointed out in the year 1877 that the interradial "proximal plates" which immediately surround the central plate in the vault of the Camarata correspond in many respects to the basal plates of the calyx. This view was further developed in Part II. (p. 15) of the 'Revision,' which appeared in 1881, and it has been pretty generally accepted in this country. In many species the proximals are surrounded by a ring of radially situated plates, which are universally recognized as representing the calyx-radials of the abactinal side. In the simpler forms of vault and in the young stages of the more complex types the central plate is thus enclosed by two alternating rings of plates, the proximal ones being interradial and the distal ones radial. The close correspondence between this arrangement and that of the apical system of a young Urchin or Starfish, and also the calyx of a stemless Crinoid like *Untacrinus*, is so striking that Mr. Wachsmuth's suggestion seemed to throw a flood of light upon the composition of the summit in Crinoids, Blastoids, and Cystids alike.

Now, however, we are told by Messrs. Wachsmuth and Springer that the proximal dome-plates are the homologues not of the basals, but of the calyx-interradials of the abactinal side, and that the central plate against which they rest represents an undivided basal disk. But although no one knows better than themselves that the radials of almost every Crinoid rest directly on the basals, they make the following generalization on p. 53:—"In the summit the central plate occupies, in relation to the radials, the same position as the basals;" and again on p. 56, "Basals and radials, interradials and anal plates, are then found to occupy the same position orally as aborally."

We are sorry to find ourselves in such direct opposition to the American palaeontologists: but we do not think they will contradict us when we say that there is not a single Crinoid in which the five (or six) calyx-interradials of the dorsal side occupy an intermediate position between the basals and radials. But unless this were so, not merely in isolated and very specialized genera*, but in the majority of typical Crinoids, both Palaeozoic and Neozoic, the two statements which we have quoted and the new morphological views which they express cannot but be altogether at variance with the real facts of the case.

The position of the calyx-radials, not merely of the Pelmatozoa,

* Such as *Acrocrinus*, for example. Many very close parallels to the extremely anomalous forms of summit which occur in some of the Palaeocrinoids may be found in the abactinal systems of Urchins, Starfishes, and Ophiurids.

but also of the Urchins and Stellerids, with regard to the abactinal centre is a very definite one; and if plates which typically occur inside the circle of dome-radials, between them and the aetinal centre, are to be regarded as homologous with abactinal plates, which are generally outside, and only very rarely form part of the circle of calyx-radials*, the word "homology" would almost cease to have any meaning in Echinoderm morphology.

There is another view of the homologies of the proximals, which was suggested by the writer in 1879, viz. that they represent the oral plates of Neocrinoids. Messrs. Wachsmuth and Springer admit that these orals are the aetinal representatives of the basals, as was pointed out by Götte; and they thus give additional support to the suggested homology between the orals of Neocrinoids and the proximals of Palaeocrinoids, which last they formerly regarded as corresponding to the basals of the abactinal side. They bring several objections to this view, some of which are well founded; but it does not appear to us to involve anything like such serious inconsistencies as their own latest theory, which necessitates an homology between one set of plates outside the circle of abactinal radials and another set inside the circle of aetinal radials!

Their objections will be fully discussed by the writer when he has finished the somewhat absorbing systematic work on which he is at present engaged. But two of them deserve notice here. In more than one place (pp. 36, 54, 58) the authors object to the theory which regards the proximals as homologous with the orals, because there are only five of the latter but six of the former plates, the posterior one being divided into two parts, usually by the anal system. This is a curious objection to come from those who tell us that these very six proximals are the aetinal representatives of the five calyx-interradials of *Cyathocrinus* and the Blastoids. On the same principle they must deny the homology of the six interradians of *Eleacrinus* with the five which occur in other Blastoids; for the posterior one is divided into two parts by the anal plate. The same difficulty occurs with respect to *Glyptaster*, *Eucrinus*, *Dorycrinus*, &c., about which we are told, on p. 13 of Part II., that "the first true interradian in the posterior area is divided, and is represented by two smaller plates, separated by a special anal plate." But unless they deny the homology of the six interradians of *Glyptaster* and *Eleacrinus* with the five of *Cyathocrinus* their objection to a theory which homologizes "six proximals with five orals" loses all its force; and we do not think that they are prepared to go so far as this.

In every Neocrinoid the anus is outside the ring of oral plates, and this has always been felt to be one of the chief objections to the theory that the proximals are orals; for plates belonging to the anal system usually enter into the ring of proximals. But we may point out that the mouth-opening, which also serves as anus in Ophiurids and in many Asterids, is within the circle of orals, and that the anal system of a regular Urchin is situated within the ring of basals which are the admitted abactinal homologues of the orals; while the

* As in the Rhodocrinidæ and the recent *Thaumatocrinus*.

early forms of exocyclic Urchins have the anus placed in or near the calycinal system, from which it gradually recedes in those of later date. May not some change of this kind be traced in the relations of the anus to the actinal system of Palæocrinoids and Neocrinoids? In any case, however, this objection about the position of the anus comes rather oddly from critics who regard the undivided central plate of the actinal side in a Palæocrinoid as the "true homologue" of the quinquepartite oral pyramid of a Neocrinoid, and are also candid enough to describe on p. 50 how the anus of the Calyptocrinidæ is strictly central, "while the central piece is bisected, and the two halves, jointly with the proximals, form the sides of the anal tube."

The authors make the same objection to the view of Allman, Wyville Thomson, Dr. Carpenter, and most later writers that the ventral pyramid of *Haplocrinus* consists of five united oral plates; for they repeatedly state that one of these five large plates which they call interradians is pierced by the anal opening, and their figure on plate v. shows an exceedingly minute puncture at its central end.

We do not say that this is not an anal opening; but, considering the length of time that *Haplocrinus mespiliformis* has been known and the many writers who have figured and described it without noticing this point, we cannot but think that further evidence is necessary. Neither anal opening nor central piece are visible in Hall's figures of *Haplocrinus clio*, nor have we been able to find them in the British species of the genus.

The authors take the same view of the five plates covering the mouth of *Stephanocrinus* and *Allagecrinus* as they do in the case of *Haplocrinus*, regarding them not as orals but as calyx-interradians. But these plates appear to us in all three genera to be truly homologous with the orals of the Pentacrinoïd larva. They cover the mouth and the origins of the ambulacra, just as the orals do in the young Neocrinoid, and this relation is not characteristic of the primary calyx-interradians in any other Crinoid. The converse of the above argument is employed by Messrs. Wachsmuth and Springer on p. 22 to disprove the "oral" nature of the interradians in *Cyathocrinus*. That these plates "are interradians, and not orals, is proved by the fact that they surround the peristome but do not cover it, and are succeeded by numerous other plates" (*i. e.* if they covered the peristome Wachsmuth and Springer would call them orals). But nevertheless the five plates which *do* cover the peristome in *Stephanocrinus*, *Allagecrinus*, and *Haplocrinus* are regarded by these authors as calyx-interradians.

It is only in the Cyathocrinidæ and in the Blastoids that the interradians have any close relation to the mouth at all; but they do not cover it in and shut it off completely from the exterior as the dome-plates of *Stephanocrinus* and *Allagecrinus* do, for they form the circumference of the peristome from which the ambulacra pass outwards over their apposed lateral edges. There is not a single Crinoid known in which plates that are universally recognized as calyx-interradians cover in the actinal centre. The very name "calyx-interradians" implies plates that are abactinal in their origin; while in Palæocrinoids, Blastoids, and Cystids alike we meet with types, such as *Allagecrinus*, *Stepha-*

nocrinus, and *Glyptosphaerites*, in which the mouth is covered by a pyramid of five closely fitting plates as in Neocrinoids (*Hyo-crinus*), Urchins (*Palæostoma*), and Holothurians (*Psolus*). There is therefore very strong evidence for regarding all these plates which have the same relations in five different classes of Echinoderms, and also occur in Asterids and Ophiurids, as mutually homologous, *i. e.* as oral plates. The very fact that actinal plates homologous with the basals of the abactinal side occur in every group of Echinoderms is sufficient to show their primary morphological importance; and it is not altogether in accordance with Wachsmuth and Springer's statement on p. 32, that "the phylogenetic evidence indicates clearly that the interradian element takes a most prominent part in the composition of the Palæocrinoidea;" and again, "Upon palæontological grounds we expect to find in the younger stages of the Palæocrinoid the oral system feebly, the interradian system extravagantly developed, while, according to Carpenter's interpretation of the plates, in the Palæocrinoid larva, the entire ventral surface from the radials up would be oral, *i. e.* actinal." This is precisely what we believe to be the case in larval forms like *Haplocrinus* and *Allagecrinus*.

The authors ask on p. 32 whether it is probable that these two genera "alone among all Palæocrinoidea should have no interradian plates?" To this we reply, "Certainly not;" for we know on the very best authority (*i. e.* their own) that interradians are "entirely absent" in some genera of the Ichthyocrinidæ; "while there are still other genera and certain species in which they are occasionally undeveloped dorsally." These remarks about the interradians occur on p. 19; and yet we are told, on p. 73, that "according to our interpretation they are present in all Palæocrinoids," and that they are "well-defined and permanent plates!"

On the same page is the following remarkable statement:—"Carpenter denies that interradians are present as a rule in Palæozoic (!) Crinoids, and he therefore does not attach to these plates the value which we think they deserve." No authoritative reference is given for this assertion, and the writer has certainly never made an explicit denial of this kind. On the contrary, he has said that calyx-interradians are "very usually present," or present in "most" Palæocrinoids; though he is by no means prepared to admit that they occur in either *Haplocrinus* or *Allagecrinus*, as Wachsmuth and Springer assert.

He must further emphatically protest against the kind of argument which is employed by these authors to demonstrate the truth of their views respecting the summit of *Allagecrinus*. The following passage occurs in the description of this structure by Mr. R. Etheridge, Jun., and the writer, which appeared on p. 286 of the 'Annals' for April 1881:—"In none of these small specimens is there any trace of an anal opening, either directly piercing an oral plate or at the margin of the dome, between the orals and radials. *The central end of one or more of the former may be marked by faint tubercles* (figs. 5 & 7, pl. xvi.); but we cannot suggest any explanation of these."

On p. 33 Messrs. Wachsmuth and Springer put the words which

we have italicized in the following manner :—"It is very significant that Etheridge and Carpenter also found in *Allagecrinus* 'at the central end of one or more of the plates faint tubercles;'" and they then make use of their version to argue against the oral nature of these plates. "Whether these represent the tubercles which we discovered upon the surface of the interradials in *Cyathocrinus multiradiatus** (pl. iv. fig. 2), we are, of course, not prepared to assert with certainty, but it is worthy of note that Carpenter regards the latter 'as the conical openings in *Granatocrinus Norwordi*' (!), and it is very possible that they are the same thing in all three groups, which would prove better than anything else that the plates bearing them are not orals but interradials. The tubercles in *Allagecrinus* are evidently of structural value, but as there is but one figured, although the description speaks of one to each plate, and this is located laterally in one specimen and centrally in the other, all interpretations by us must necessarily be more or less problematical. We are inclined, however, to believe that the lateral one (fig. 5), in analogy with *Haplocrinus*, represents the anal opening, *i. e.* the larger tubercle in *Granatocrinus*, and the central one, if it exists at all, the central piece."

The whole point of this argument in the comparison of *Allagecrinus* with *Cyathocrinus Gilesi* and the tubercles upon each of its five interradials depends upon the supposed fact that "the description speaks of one to each plate." But all that the description says is that a faint tubercle *may be* present on *one or more* of the plates; and of the nine figures given of the summit only four show any trace of tubercles at all, and then of but one only, as Wachsmuth and Springer admit. Under these circumstances we should like to know why the tubercles are "evidently of structural value."

Furthermore, it was explicitly stated that there is no trace of an anal opening directly piercing an oral plate, as has since been described by Wachsmuth and Springer in *Haplocrinus*. A very large series of specimens was examined, and special attention was directed both to this point and to the possible presence of a central plate; but the result in both cases was a negative one. Wachsmuth and Springer tell us, however, on p. 53, that the central plate "is the only summit plate which is represented in every Palæocrinoid." This seems to us to be rather a bold assertion. There are many forms in which the summit is as yet unknown; while, though well defined in *Culicocrinus*, *Pisocrinus*, *Allagecrinus*, and two species of *Haplocrinus*, it has never yet been found to contain a central plate. The analogies of *Stephanocrinus* and *Elæocrinus* among the Blastoids, and of *Glyptosphaerites* and *Caryocrinus* among the Cystids, show that the presence of a central actinal plate is not a constant character in either group. Why, then, should it be described as such in the Palæocrinoids, when there is at least as good evidence to the contrary as in the undisputed cases of *Stephanocrinus* and *Glyptosphaerites*?

We cannot but admire the courage of Messrs. Wachsmuth and

* It appears from a reference to the explanation of pl. iv. fig. 2 that the specific name *multiradiatus* should read *Gilesi*. On the other hand, according to the explanation of fig. 6, *C. multiradiatus*, on p. 22, should read *C. multibrachiatus* as on p. 65.

Springer in thus rendering themselves liable to adverse criticism; and the same remark applies to various other morphological statements on their part.

They think that they have discovered a method of inferring the presence or absence of underbasals, more especially in those types which have the lower part of the calyx partially concealed. They give the following general rules, to which they "have not found a single exception among all Palæocrinoidea" (pp. 7, 8):—

"1. In species with underbasals, whenever the column is pentangular, its longitudinal angles are directed interradially, the sides and columnar cirrhi radially; on the contrary, in species with basals only, those angles are radial, the sides of the column and the cirrhi interradial.

"2. When there are underbasals and the column is pentapartite, the five sections of the column are radial, the longitudinal sutures interradial, the radiation along the axial canal radial; but the opposite is the case when basals only exist."

So far as we are aware, the first of these two rules always holds good among Palæocrinoidea; but there seems to us to be something seriously wrong about the statement of the second. It is illustrated by two figures on pl. vi.: fig. 15 is said to represent the "Basals of *Barycrinus*, with the joint of the quinquepartite column." No basals are shown in the figure, however, but only the underbasals (*u*) and the five sections of the first columnar joint (*c*). The arrangement of the figure is as follows:—the five sections of the stem are interradial, its longitudinal sutures radial, and the processes of the axial canal also radial. This (if correct) would suggest a *lapsus calami* in rule 2, the words *radial* and *interradial* having been transposed; and an examination of fig. 13 confirms this idea. It represents the basals of an undescribed monocyelic genus (*Stenocrinus*) with a quinquepartite column. The sections of the column are radial and the sutures interradial, whereas exactly the reverse ought to be the case according to rule 2. Apart from this unfortunate transposition, however, fig. 13 (if correct) shows that there is at least one exception to a part of rule 2, for the processes of the axial canal are *radial* both in fig. 13 and in fig. 15, whereas according to rule 2 they ought only to be so in the latter (*Barycrinus*).

This question is further complicated by the fact that in the "Diagram of *Barycrinus*," which appeared on pl. i. of the first part of the 'Revision,' the processes of the axial canal are *interradial*. Which of these two figures of *Barycrinus* is the correct one, the first or the second?

A precisely similar transposition to that just mentioned occurs in Part I. of the 'Revision' (p. 101). The sections of the column of *Barycrinus* are there said to be radial, while "the sutures are interradial, the opposite of *Heterocrinus*, in which they are radial." On p. 64, however, the ridges of the column of the latter genus are said to be radial, which would give the sutures an interradial position. The figure in Part III. of the "Basals of *Heterocrinus*, with a joint of the tripartite column" (pl. vi. fig. 14) is also rather puzzling, because neither sutures nor sections have either an inter-

radial or a radial position, and *Heterocrinus* has been described by Hall, Meek, and others as having a "pentapartite" column.

Having discovered what appear to be almost invariable rules for determining the presence or absence of underbasals in a Palæocrinoid, the authors turned their attention to the Neocrinoidæ, with the following result (p. 8):—"Among Neocrinoidæ our investigations could be extended only to comparatively few genera, as unfortunately these forms have either a round column or a circular canal. Only in a few species of *Pentacrinus*, *Millerocrinus**, and *Apiocrinus* did we succeed in making out one or the other of these points. In these genera, underbasals are said to be absent, but, curiously enough, the outer angles of the column are interrarial, the cirrhi and radiation along the axial canal radial, exactly as in the column of Palæocrinoidæ with underbasals, and, what is more remarkable, as in *Extracrinus*, in which, on the contrary, underbasals are said to be present. The latter seems to suggest that probably many Neocrinoidæ either possess small underbasals or these were present in their larval form." On p. 71 it is positively asserted that Neocrinoids "are built upon the plan of dicyclie Crinoids. The angles of the column are directed interradially, the cirrhi radially."

Let us see how far these remarks are justified by facts. In the first place, there are no cirri at all upon the stem in two out of the three genera which are mentioned by the authors on p. 8; and it would therefore have been better if they had said with respect to these three genera that the cirri are radial "when present."

A long series of plates illustrating the structure of these two genera (*Apiocrinus* and *Millerocrinus*), which have no cirri on the stem, is given by Mons. de Lorient in the work on the French Jurassic Crinoids which we have noticed above; and as Messrs. Wachsmuth and Springer have copied two of the figures which it contains, we may fairly conclude that they have studied it with some care. We have examined it for the purpose of testing their statements, and have been surprised to find that in every species of *Apiocrinus* which has pentagonal uppermost stem-joints the angles are directed radially; and yet it is one of the three genera of which Wachsmuth and Springer state that "curiously enough the outer angles of the column are interrarial," as in dicyclie Crinoids. In the case of *Millerocrinus* the angles of the stem are radial in about half the species, just as in *Apiocrinus*; while they are interrarial in the other half, which includes the two species in which underbasals are figured and described by de Lorient. This latter point therefore tells in favour of the authors' theory, as also does the fact that *Extracrinus* has underbasals and a column with interrarial angles and radial cirri. But it is clear, on the other hand, that their very positive statement on p. 71 will need some considerable qualification before it can be applied to all the Neocrinoids.

The genus *Pentacrinus* presents difficulties of precisely the same kind. Although it has no underbasals the angles of its stem are

* This is generally spelt *Millerocrinus* by students of the Neocrinoidæ.

interradial and its cirri radial, and it is therefore "built upon the plan of dicyclic Crinoids;" but the processes of the axial canal are interradial, and not radial as they ought to be according to the generalizations on pages 7 and 8, which we have quoted above. The 'Challenger' Report upon the stalked Crinoids, which was in Mr. Wachsmuth's hands nearly four months before the presentation of his Part III. to the Philadelphia Academy, contains figures which illustrate this point in four recent species of *Pentacrinus*, and he would therefore have done well to make sure of his facts before generalizing on the subject. We doubt if there is a single species of *Pentacrinus* which has a radial axial canal. It is curious, however, that in the closely similar genus *Metacrinus* the processes of the axial canal are radial, though no underbasals are present as in *Extracrinus*. But perhaps the most curious anomaly is presented by the two allied genera *Bathycrinus* and *Rhizocrinus*. In the former, as in *Pentacrinus*, the angles of the top stem-joints are interradial, but so are the processes of the axial canal; while exactly the reverse is the case in *Rhizocrinus*, which, like *Apioecrinus*, has radial angles to its cirrus-less stem, though the processes of the axial canal are also directed radially.

All four genera agree, however, in the absence of underbasals, though one of the characters which should be correlated with their presence, together with one which should not, occurs in each type.

We cannot but wonder that with these facts before them Messrs. Wachsmuth and Springer should have committed themselves to the very positive statement that "the Neocrinoids are built upon the plan of dicyclic Crinoids."

There is another case of the same kind to which we must allude (p. 62). They have noticed "narrow grooves upon the inner surface of the vault, which meet beneath the median part of the oral plate, and follow the subtegmina galleries which enclose the ambulacral tubes;" and they have reasons for thinking that these grooves and the ridges which correspond to them on the internal casts "do not represent the ambulacral tubes." We will not discuss this point, but pass on to the conclusions which they draw on pages 62 and 137 (especially the latter)—"That the grooves are placed along the solid walls of the test, has led us to suppose that they were axial canals (!), and that perhaps in these Crinoids, contrary to others, and to the Neocrinoidea generally, the entire nervous system was located at the oral side, in conformity with other Echinoderms. Our interpretation becomes more plausible when we consider that in the Camarata the radials are never pierced by canals, and it would be difficult to understand how these ponderous arms could have moved without axial cords, unless their movements were altogether passive."

We wonder that the authors do not see that the same argument would hold good for the vault-plates, which are not perforate but merely grooved; and even supposing their statement about the Camarata to be invariably true, it does not imply, as they assume, that there were no nervous axial cords on the inner surface of the

grooved but imperforate radials. In the early Pentacrinoid larva the axial cords lie not within but on the ventral surface of the basals, radials, and brachials, "which are then mere flat plates; by an endogenous thickening of the calcareous network of those plates the axial cords come to lie in furrows channelled out in their ventral surfaces; while by a further endogenous growth of that network these ventral furrows are completed into canals, and it is by a still further endogenous thickening that these canals finally come to occupy the centre of each calcareous segment"* . This has been pointed out over and over again of late years, and it has been shown that each transitory condition of the Neocrinoid is a permanent one in certain Palæocrinoids. But according to the reasoning employed by Wachsmuth and Springer the early Pentacrinoid has no dorsal nervous system, because its radials are not "pierced by canals." Furthermore, the arm-joints of many, if not all, Camarata contain canals which all converge on the grooves of the radials. Were there no axial nerves within these canals? Apparently not; for it is suggested that "the entire nervous system was located at the oral side." If there were any real grounds for supposing this to have been the case, it would be necessary to remove the Camarata from the Crinoids altogether and to establish another class of Pelmatozoa for their reception. We believe that a much more satisfactory explanation may be given of these grooves upon the inner surface of the vault of the Actinocrinites than that suggested by the authors, who do not seem to have sufficiently considered the difficulties into which it would lead them; and we shall be much surprised if they do not withdraw it in the concluding section of the 'Revision.'

We may be permitted to express the hope that a little more care will be exercised in correcting it for the press than has been given to the one under review. References to wrong and even to non-existent plates and the misspelling of specific names might have been avoided. There are three mistakes on p. 127 alone, while such errors as "*Platynieridæ*" and the statement on p. 41 that the anus of *Coccocrinus* and *Culicocrinus* "is located between the first and second radials" ought not to have escaped notice. Others of a similar kind have been already mentioned incidentally. The reader must also be cautioned against misunderstanding the authors' very free use of the word "evidently" when discussing controverted questions. It is employed as a short version of "in our opinion;" as, for example, in the passage respecting *Allagecrinus* on p. 33, which we have quoted above; the statement on p. 58 that the interradials of *Haplocrinus* "evidently separated in the growing animal and the oral plate moved outward;" and another on p. 55 that the underbasals of *Stemmatocrinus* are "evidently fused together to a single piece."

Space does not permit our noticing many other morphological points in which we altogether disagree with Messrs. Wachsmuth and Springer; and we cannot help thinking that in some cases, besides that of the underbasals, they have committed themselves to gene-

* W. B. Carpenter, Proc. Roy. Soc. 1876, p. 454.

ralizations which will not bear investigation, and are premature, to say the least of it. But this does not prevent our expressing our full sense of the very high value of this, and also of both the preceding parts of their 'Revision of the Palæocrinoidea.' They have brought order out of chaos in a truly scientific manner, for which naturalists in general cannot be too grateful. The points on which we can venture to challenge their decision with respect to the value of species, genera, or families are indeed few and far between; and if we cannot say the same upon certain morphological questions, we must remember that although the authors began their Crinoid work merely as collectors, they have strenuously endeavoured, more than any other American writers on the Pelmatozoa, to interpret the structure of their fossils by the only method which can possibly give any value to their conclusions, viz. a knowledge of the morphology of recent Echinoderms. Their latest publication is illustrated by half a dozen plates, the last four of which are filled up by diagrams of various kinds; but the first two, which have been photographed from the drawings of Mr. Orestes St. John, are admirable expositions of actual structure as revealed by the choicest specimens at the disposal of the authors.

We shall look with very much interest for the publication of the concluding section of this most valuable work; and we should be only too well pleased to hear that it is but the precursor of a larger one to be issued as one of the finely illustrated monographs of the United States Geological Survey. We have heard a rumour as to the possibility of this, and every palæontologist will hope that it may prove to be a well-founded one.

P. HERBERT CARPENTER.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

November 4, 1885.—Prof. T. G. Bonney, D.Sc., LL.D., F.R.S.,
President, in the Chair.

The following communications were read:—

1. "On the Premaxillaries and Scalpriform Teeth of a large Extinct Wombat (*Phascolomys curvirostris*, Ow.)." By Sir Richard Owen, K.C.B., F.R.S., F.G.S.

The specimen described in this paper is a cast from a fossil discovered in a late exploration of the Wellington bone-caves, and sent to the author with some other casts from the same collection by the authorities of the Australian Museum, Sydney, New South Wales.

The fragments in question consist of the premaxillary bones, containing a pair of scalpriform incisors, 160 millim. ($6\frac{1}{2}$ inches) long, measured along the outer curve.

The teeth and the fragments of bone in which they are implanted were described in detail, and referred to the Wombat family. The